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DRAWINGS ATTACHED

1 212 658

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(54) SYNCHRONIZING COUPLING

(71) We, ZURN INDUSTRIES, INC., a Corporation organised under the laws of the State of Pennsylvania, United States of America, of 1801 Pittsburgh Avenue, Erie, Pennsylvania, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to synchronizing couplings and, especially though not exclusively, to a combination flexible coupling and synchronizing clutch.

The object of the invention is to provide a synchronizing coupling which is simple in construction, economical to manufacture, simple and efficient to use, and which in its preferred embodiment combines the function of flexible coupling and synchronizing clutch.

Accordingly the invention provides a synchronizing coupling comprising a first hub having teeth and a sleeve having teeth, said hub and said sleeve being axially slidable relative to each other to bring said hub teeth and said sleeve teeth into engagement with each other when there is no relative rotational velocity between said hub and said sleeve, a ring, said ring having a friction surface adapted to frictionally engage a friction surface on said sleeve, teeth on said ring, said ring teeth being disposed between said hub teeth and said sleeve teeth when said hub and said sleeve are in disengaged relation with each other, means on said hub teeth cooperating with means on said ring teeth to block said hub teeth and said sleeve teeth from moving into meshing relation with each other when a relative rotational velocity exists between said hub and said sleeve, and means on said coupling for forcing said frictional surfaces into engagement with each other and said cooperating means on said hub teeth and said ring teeth into engagement with each other, when said sleeve teeth and said hub teeth are slidably moved toward each other, whereby rotational force may be transmitted between said hub and said sleeve, wherein a second hub is provided having teeth engaging further teeth on the sleeve, said hubs are axially spaced from each other, said ring comprises a cone ring, and the friction surface on said ring comprises an external conical surface adapted to engage an internal conical surface on said sleeve.

Preferably the teeth of the first and/or second hubs have tips and/or flanks shaped to conform to part of an ellipsoid, thus providing a degree of flexibility in the coupling.

Preferred embodiments of the invention are described with reference to the accompanying drawings in which:—

Fig. 1 is a cross sectional view of synchronizing coupling according to the invention.

Fig. 2 is a schematic view of the circumference at the pitch diameter of the gear elements and cone ring of the embodiment shown in Fig. 1.

Fig. 3 is another schematic view of the gear teeth.

Fig. 4 is a cross sectional view of another embodiment of the invention.

Fig. 5 is a view of yet another embodiment of the invention.

Now with more particular reference to the drawings, the coupling shown is made up of a drive hub 10 and a driven hub 11 which may be connected through sleeve halves 13 and 21 to drive a load.

The drive hub has crowned external teeth 30 thereon which mesh with internal sleeve teeth 31 on sleeve half 13.

The two sleeve halves are connected together by means of bolts 33 which pass through holes in the external flanges on the sleeve halves. A spacer plate 34 is fixed in position between the sleeve halves 13 and 21.

The coupling shown in Fig. 1 is in the

disconnected state with a synchronizing cone ring 12 enclosing disengaged external teeth 16 on the driven hub 11.

In the development of the circumference at the pitch diameter of the gear elements and cone ring 12, shown in Fig. 2, cone ring 12 has an inwardly directed annular flange 20^1. Rotation of the sleeve 13 and a pressure plate 14 driven thereby exerts a frictional drag or torque upon the cone ring 12 and pressure upon the pressure plate by springs 15 applies an axial force upon the cone ring 12. The axial force and torque upon the cone ring 12 forces it over the hub teeth 16 in such a manner that the flange 20^1 rests against the face of driven hub 11. The distance between the ring flange 20^1 and a chamfer 19 on teeth 17 carried internally by the cone ring 12 is less than the length of the hub teeth 16, thereby assuring that the chamfer of the hub teeth 16 rests upon the chamfer 19 of the cone ring teeth 17. If the rotational direction of the sleeve half 21 is opposite, the opposite chamfers 19^1 on the cone ring teeth 17 will engage the opposite chamfer 35 or the hub teeth.

An application of axial force, by a hydraulic cylinder or some other device, as indicated generally at F in Fig. 1 will cause an axial motion of the sleeve halves 13 and 21 in the direction of the force until the cone ring 12 begins to seat itself on an internally coned surface within the sleeve half 21. The contact of the outside of the cone ring 12 with the inner surface of the sleeve half 21 functions as a cone type clutch developing torque between the cone ring 12 and the sleeve half 21. The torque upon the cone ring 12 will be in the direction of the sleeve rotation.

An analysis of Fig. 3 will indicate that as long as the torque developed between the cone ring 12 and hub 11 is high enough, the axial force cannot push the teeth 17 on the cone ring 12 past the hub teeth 16 which block its axial travel by virtue of the contacting chamfers on teeth 16 and 17. For this to be so the torque component in the axial direction must be equal or greater than the applied axial force. The axial component of torque can be regulated by altering the angle of the contacting chamfers of teeth 16 and 17. The blunter the teeth or steeper the angle, the greater the axial component required to shift the clutch. The axial force due to torque can also be increased by an increase of the torque itself.

The torque can be increased by decreasing the included angle of the friction cone and/or by an increase in axial force. With the foregoing in mind, an increase in axial force also increases the cone ring friction torque and subsequently increases the axial blocking force between the hub and cone ring teeth. The proper selection of cone ring angle and teeth chamfers can establish a system of forces that can block passage of the hub teeth past the cone ring teeth regardless of the magnitude of axial force. The only force neglected in the foregoing discussion is the reaction torque presented by the driven hub. This reaction torque consists of the engaging torque or the resistive torque of a load connected to the hub and the accelerating torque of that same load. If the driven hub is rotating at a different speed from the drive hub, then a torque can be transmitted between the two shafts via the cone ring for the purpose of accelerating the driven hub 11 to a speed equal to the speed of the drive hub 10. Once the differential between the speeds of the drive hub and the driven hub is zero, there can no longer be an accelerating torque or a reaction torque.

The loss of reaction torque at the point where speed synchronism upsets the balance of forces upon the teeth chamfers will result in the hub pushing past the cone ring, and engagement of the hub teeth 16 with the teeth 18 formed internally of the sleeve half 21 will result.

In the embodiment of the invention shown in Fig. 4, a drive hub 110 is shown connected to a drive sleeve half 113, which is connected by bolts 133^1 and a spacer 137 and bolts 133 to a sleeve half 121. A spring 115 similar to the spring 15 in Fig. 1 exerts a force on a cone ring 112 through a pressure plate 114. An axial operating force can be applied through a shifting collar 140, which applies a force to a spacer plate 134. The operating force may be applied for example by a remotely controlled hydraulic cylinder acting on the shifting collar 140; The spacer 137 and the spacer plate 134 shift the sleeve formed by the halves 113 and 121 in one direction or the other.

The coupling of Fig. 4 includes the spacer 137 so as to allow adequate room to remove the synchronizing cone ring 112 without moving the equipment connected through the hubs 110, 111. This spacer 137, once removed itself by release of the bolts 133, 133^1, allows removal of all the components of the coupling without removing the connected equipment. The hubs have keyways, as shown, that may be used to support them on suitable shafts for connecting them to rotating machinery. The coupling while disengaged can be supported radially by bearings associated with the integral shifting collar 140 or by an internal bearing.

If operation of the coupling is required only while the coupling is rotated at a speed, then the centrifugally operated assembly illustrated in Fig. 5 may be used. The operating force in this case is developed by injecting oil into an appropriate portion of a cylinder formed around the coupling

whereby the rotation of the coupling develops pressure in the oil centrifugally which pressure is applied axially to a face of a piston formed by or attached to an outwardly extending flange or flanges on the coupling sleeve. In this embodiment, hubs 211 and 210 are connected through sleeve halves 213 and 221. The general construction and the shifting arrangement in this embodiment of Fig. 5 is similar to that shown in Fig. 1: however, a cylinder is defined by an outwardly extending flange 245 formed on the hub 210 and a cylinder head 246, bolted by means of bolts 249, 251 to a cylinder body made up of halves 247 and 248 connected together by bolts 250. The cylinder half 248 has internal grooves 252 and 253, which receive a ring 254 when the sleeve formed by halves 213 and 221 is in one of two respective positions, either with a piston 234 against a stop 259 or in an opposite extreme position with the coupling engaged. A sealing ring 270 is situated between the sleeve half 221 and the piston head 246. Oil may be inserted into the portion of the cylinder on one side of the piston through the opening 260 and may be exhausted through the opening 261. Likewise, oil may be inserted into the other portion of the cylinder through opening 263 and exhausted through opening 264 to move the piston 234, and therefore to cause the gear teeth 216 on the hub 211 to engage sleeve teeth 218 through the synchronizing action of the cone 212.

In each embodiment, the external teeth on the drive and/or driven hubs are preferably provided with crowned flanks and tips as is described in more detail in U.S. Patent Specification No. 2,682,760, the tips and crowns being shaped to conform to part of an ellipsoid. The crowned flanks in contact with the flanks of the teeth on the sleeve halves result in well distributed contact. The radially crowned and chamfered tips of the hub teeth eliminate fillet root interference with the sleeve teeth.

The operation of the couplings, when engaged, is identical to that of the flexible coupling described in the above U.S. patent specification. Torque is transmitted through the crowned gear teeth of the hubs and the internal teeth of the sleeve halves. Concentricity of the sleeve and the hubs is maintained by the ball and socket piloting action of the spherically or ellipsoidally crowned teeth of the hubs mating with the cylindrically arranged teeth of the sleeve halves. This method imparts excellent concentricity for exceptional dynamic balance.

WHAT WE CLAIM IS:—

1. A synchronizing coupling comprising:
a first hub having teeth and a sleeve having teeth,
said hub and said sleeve being axially slidable relative to each other to bring said hub teeth and said sleeve teeth into engagement with each other when there is no relative rotational velocity between said hub and said sleeve,
a ring,
said ring having a friction surface adapted to frictionally engage a friction surface on said sleeve,
teeth on said ring,
said ring teeth being disposed between said hub teeth and said sleeve teeth when said hub and said sleeve are in disengaged relation with each other,
means on said hub teeth cooperating with means on said ring teeth to block said hub teeth and said sleeve teeth from moving into meshing relation with each other when a relative rotational velocity exists between said hub and said sleeve,
and means on said coupling for forcing said frictional surfaces into engagement with each other and said cooperating means on said hub teeth and said ring teeth into engagement with each other, when said sleeve teeth and said hub teeth are slidably moved toward each other, whereby rotational force may be transmitted between said hub and said sleeve, wherein
a second hub is provided having teeth engaging further teeth on the sleeve,
said hubs are axially spaced from each other,
said ring comprises a cone ring, and the friction surface on said ring comprises an external conical surface adapted to engage an internal conical surface on said sleeve.

2. A coupling according to claim 1 wherein the teeth of said first and/or second hubs have crowned flanks.

3. A coupling according to claim 1 or 2 wherein the teeth of said first and/or second hubs have crowned tips.

4. A coupling according to any of the preceding claims wherein said sleeve has a flange member extending outward forming or carrying a piston, and further comprising:
a cylinder member fixed to said second hub and surrounding said flange,
said flange having sealing means slidably engaging the inside surface of said cylinder,
a cylinder head on said cylinder,
means on said cylinder head slidably engaging said sleeve,
means to insert fluid into said cylinder on a first side of said piston to force said second sleeve teeth toward said second hub teeth when the sleeve is rotated at a

speed sufficient to develop centrifugal force within said fluid,

and means for inserting fluid into said cylinder on a second side of said piston whereby said second sleeve teeth are forced in a direction from said second hub teeth, when oil pressure is developed in the cylinder.

5. A coupling according to any of the preceding claims wherein said means on said hub teeth and said ring teeth comprise chamfered ends on said teeth,

said chamfered ends on said hub teeth and on said ring teeth being held in engagement with each other and blocking axial movement of said sleeves whenever said ring and said hub are rotating at different speeds.

6. A coupling according to any of the preceding claims wherein the friction surface on said sleeve is an internal conical surface complementary to the external conical surface on the ring, and further comprising:

a pressure plate having an annular surface engaging said ring on a side thereof opposite said external conical surface,

and spring means on said sleeve engaging said pressure plate and urging the latter toward said ring.

7. A coupling according to any of the preceding claims wherein:

said ring has an inwardly directed flange on the end thereof remote from the smaller diameter end of its conical surface,

said teeth on said rings are spaced from said flange and said hub teeth are disposed between said ring and said flange when the flanks of said hub teeth and the flanks of said ring teeth are out of engagement and said coupling is uncoupled.

8. A coupling according to claim 4 wherein:

said cylinder has a first groove inside said cylinder and a second groove inside said cylinder spaced from said first groove,

and said piston has a piston ring,

said piston ring being disposed in said first groove when said first hub teeth are out of engagement with said sleeve teeth,

said piston ring being disposed in said second groove when said first hub teeth are in engagement with said sleeve teeth.

9. A synchronizing coupling substantially as hereinbefore described with reference to Figures 1—3 or Figure 4 or Figure 5 of the accompanying drawings.

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1212658 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

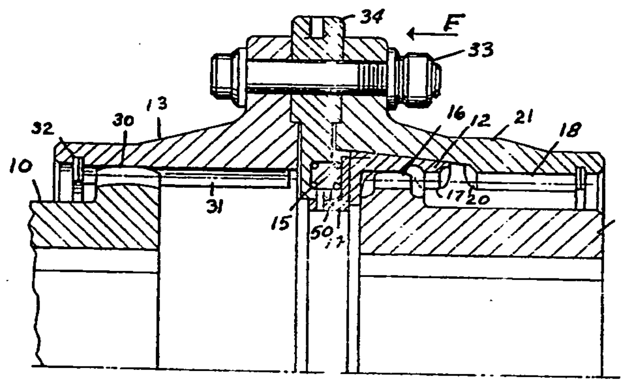

Fig 1

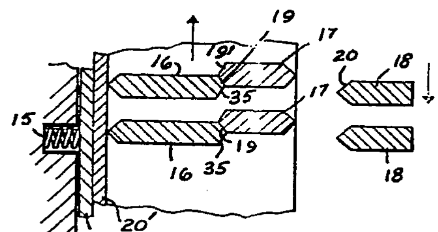

Fig 2

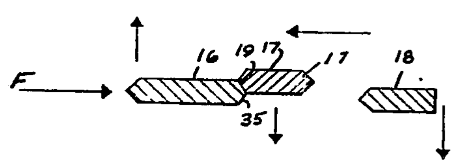

Fig 3

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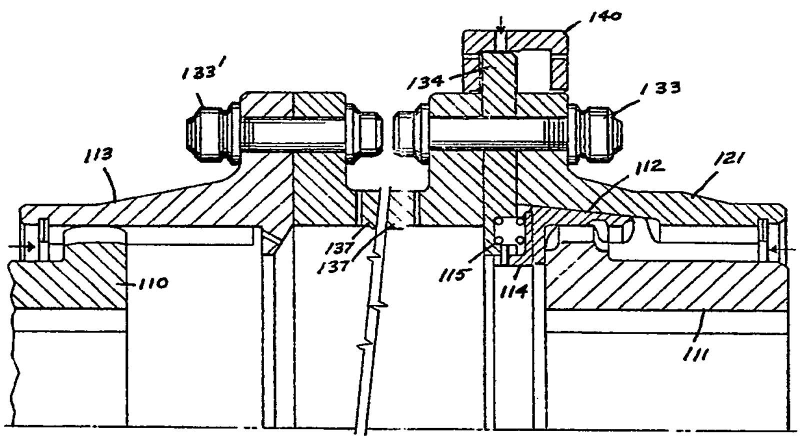
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FIG 4

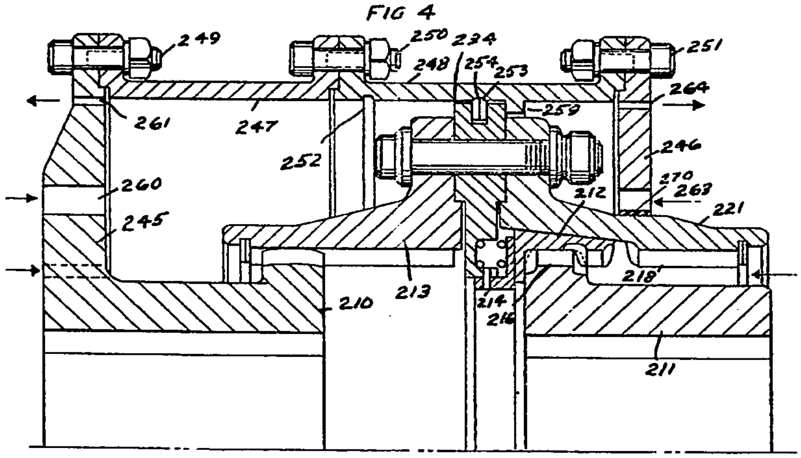
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FIG 5